Pain Management: Acute and Chronic Techniques

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Background

- Excela Health School of Anesthesia: DNAP, MHS
- University of South Florida: Simulation-Based Academic Fellowship in Advanced Pain Management
  - Board Certified in Non-surgical pain management: NSPM-C
- Middle Tennessee School of Anesthesia: Acute Surgical Pain Management Fellowship
- WVANA Pain Management, Government Relations Chairs. 1st Year Board of Directors

Learning Objectives

- Summarize and define various ultrasound terminology
- Summarize nociception, transmission, conduction, and pain modulation
- Summarize pain pathways, pain theories, and modulation sequence
- Identify relevant sonoanatomy and define clinical pearls to optimize ultrasound imaging
- Discuss dosing parameters for pain catheters and regional techniques

Learning Objectives

- Summarize pharmacological approaches to pain management
- Summarize opioid sparing techniques
- Identify the correct facial landmarks and craniofacial blocks for chronic migraine
- Discuss the dosing parameters for Botox treatment for migraines
- Discuss local anesthetic adjuvants for prolonged analgesia

Pain: What is Pain?

Pain: What is Pain?

- Pain can be described as a localized or generalized unpleasant bodily sensation or complex of sensations that causes mild to severe physical discomfort and emotional distress and typically results from bodily disorder, such as injury or disease.

Reference: https://www.merriam-webster.com/dictionary/pain

Transduction

- Energy from a stimulus (mechanical, thermal, or chemical) applied to a peripheral nerve receptor. This energy must be converted to an electrical signal. This results in depolarization of the peripheral nerve terminal.

Transformation/Conduction

- The generator potential (from the depolarization) must initiate an action potential. This action potential must be successfully propagated from the peripheral terminal to the central terminal.

Transmission

- The propagated action potential must cause high enough increase in intracellular calcium ions to enable the release of enough neurotransmitters to initiate the whole process once again in the second order neuron.

Modulation

- Modulation of the pain occurs in specific areas of the spinal cord. This particular area is located in the dorsal horn of the spinal cord. Within the dorsal horn, there is a classification of the laminae system.
  - Rexed's Laminae: The main laminae in regard to pain modulation is Rexed's Laminae II or commonly referred to as, the Substantia Gelatinosa.
  - This is the location where inhibitory neurotransmitters such as GABA or Enkephalins modulate pain responses.

Overview of Spinal Cord arrangement

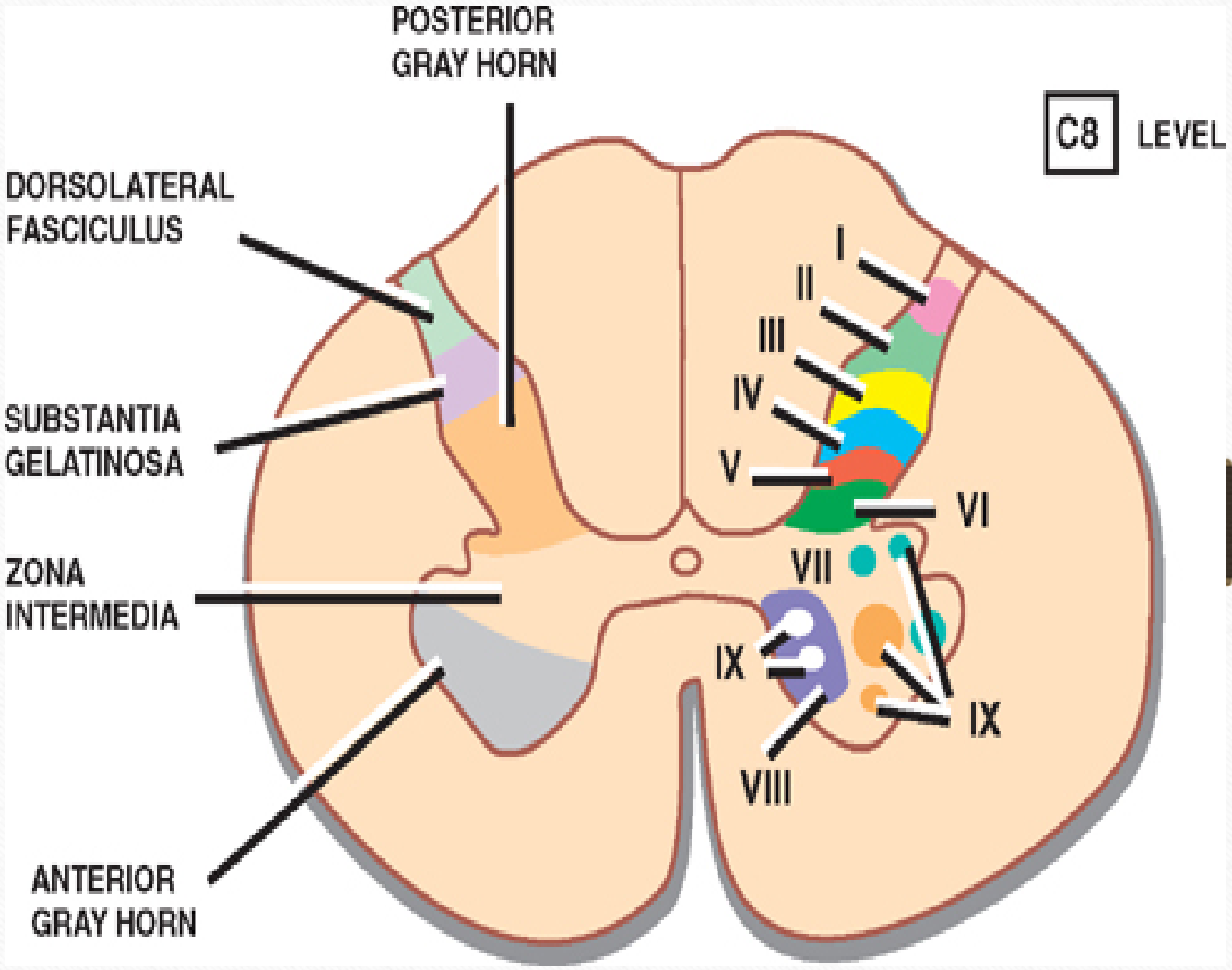


Image retrieved: https://neupsykey.com/spinal-cord-9/

Overview of Transduction, Transmission, Modulation, Perception

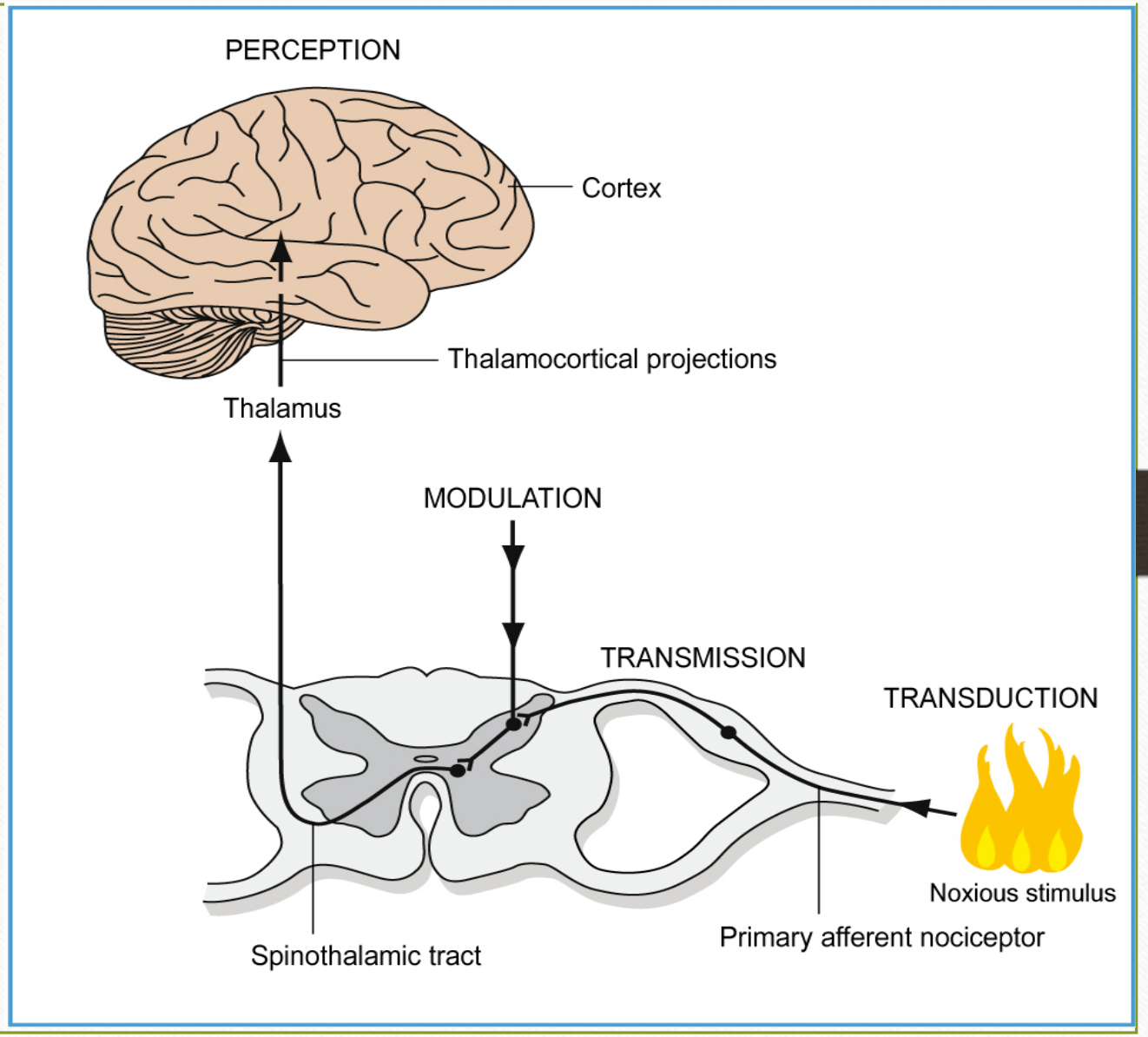


Image retrieved:
https://www.theveterinarynurse.com/review/article/understanding-the-mechanisms-behind-acute-pain-in-dogs-and-cats

Pain Pathway and Perception

- After the pain perception (action potential) reaches the second order neurons in the Substantia Gelatinosa (Rexed's Laminae II), the signal crosses to the contralateral side and ascends via the lateral spinothalamic tract.
- The pain perception occurs in the somatosensory cortex. The pain stimulus travels via the second order neurons, where they synapse with supraspinal sites and third order neurons. Via the third order neurons, the stimulus will travel to the somatosensory cortex, where it is decoded for pain perception.
- The nerve fibers responsible for pain perception:
  - A Delta: myelinated, Large diameter, and fast
  - C Fiber: Non-myelinated, small diameter, and slow

Spinothalamic Pain Pathway

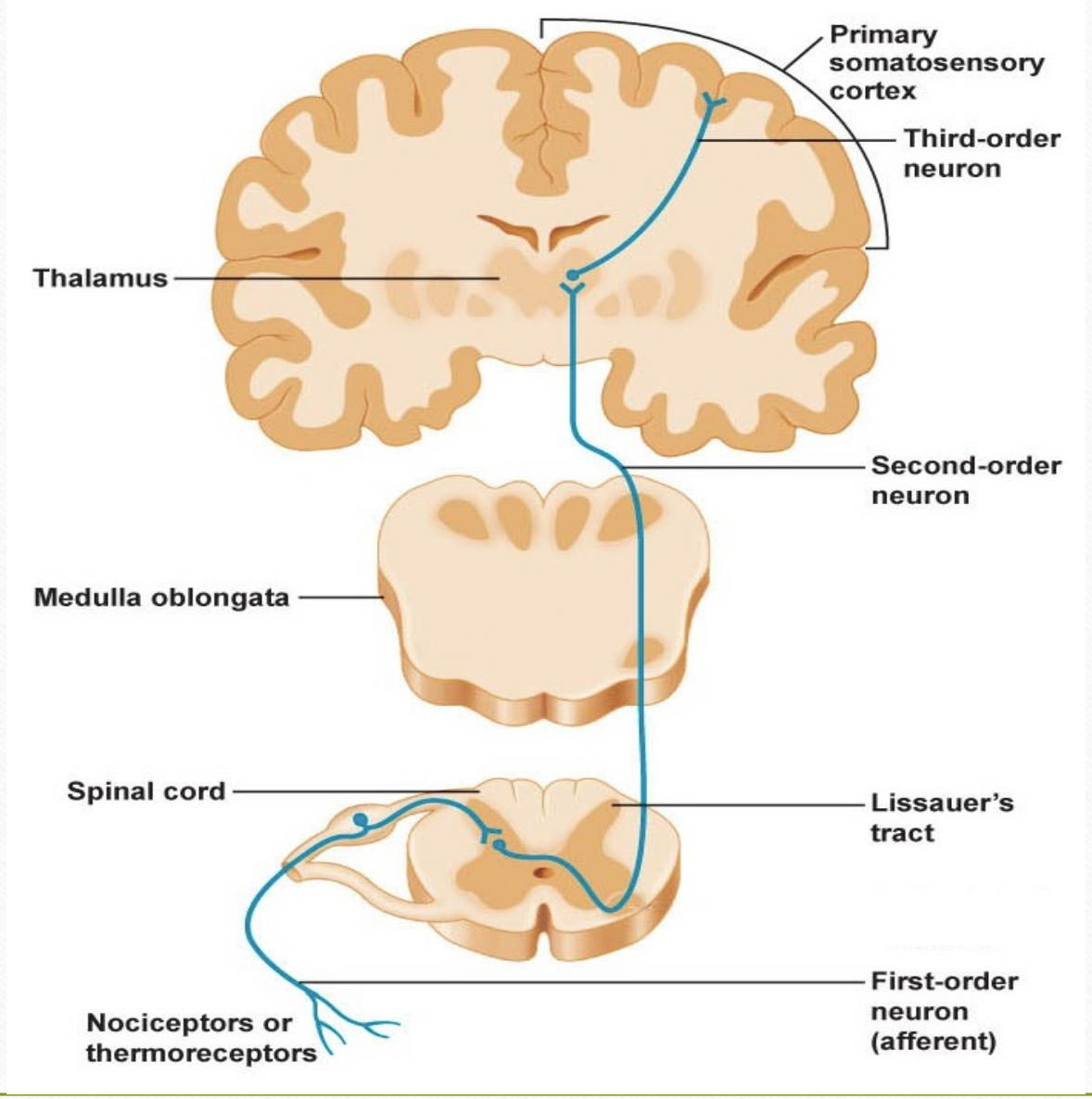
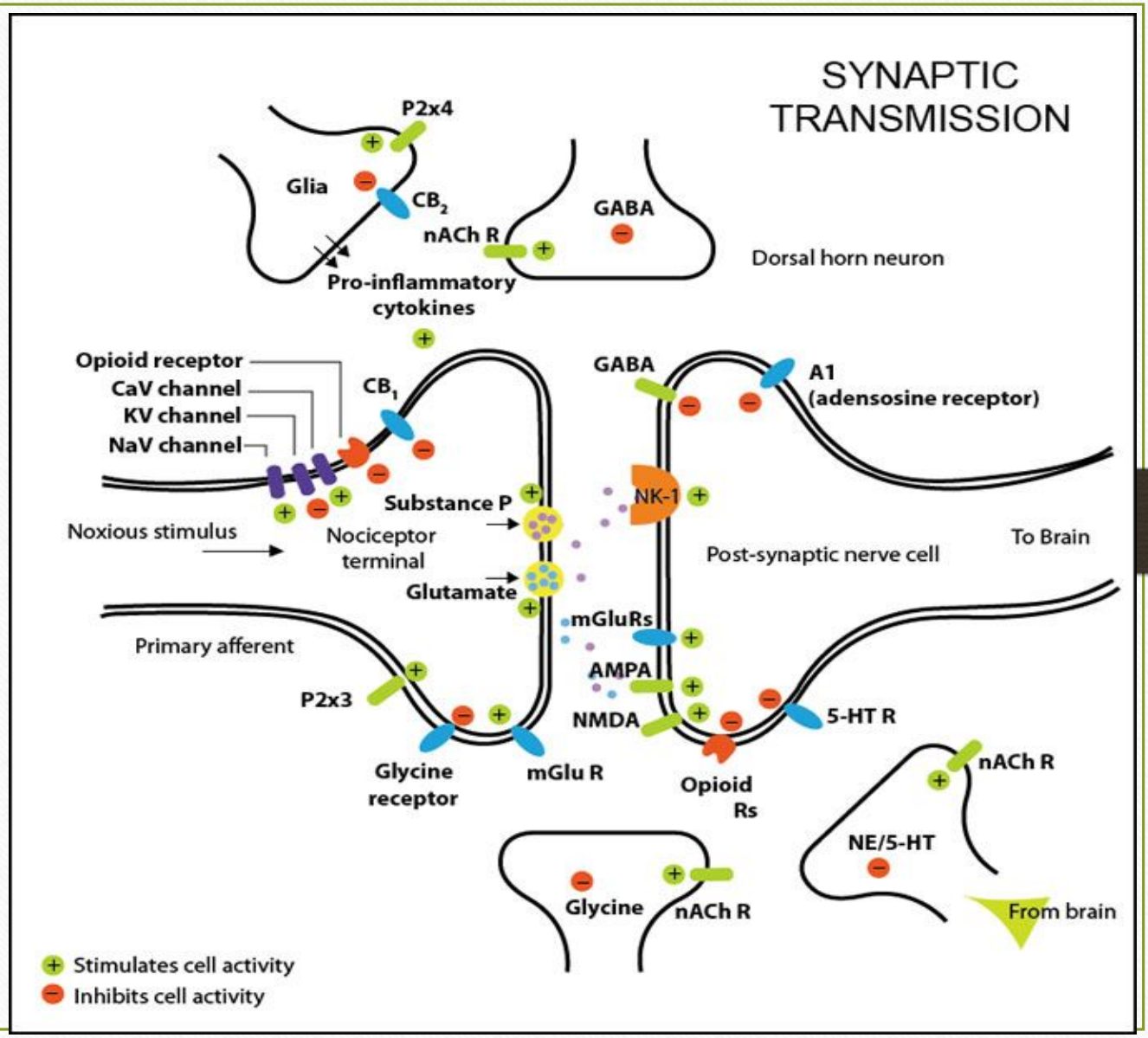


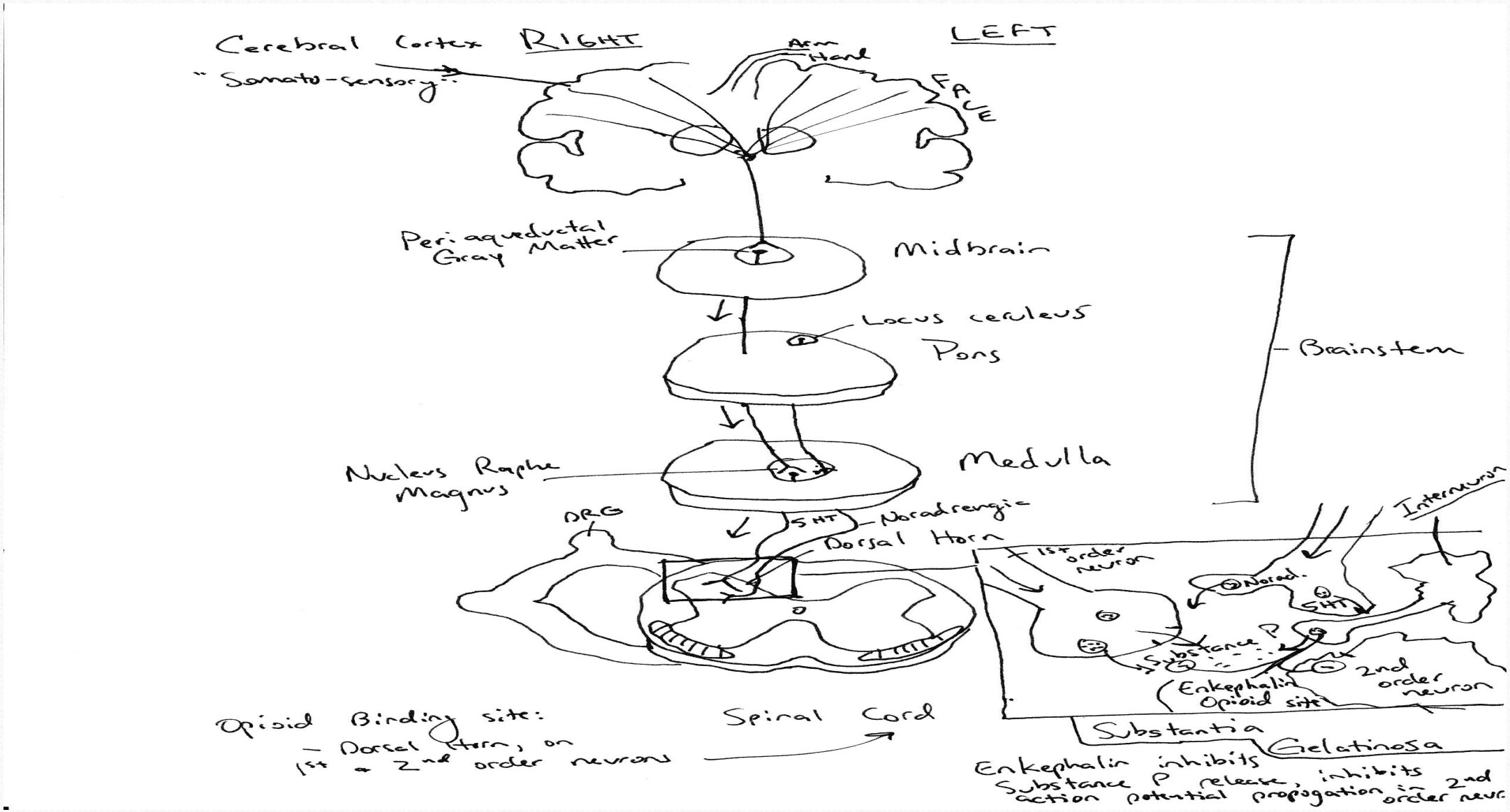
Image retrieved: https://brainstuff.org/blog/structure-and-function-of-the-spinothalamic-pathways

Pain Modulation

- Once the pain is perceived in the somatosensory cortex, descending pathways provide a means for modulating painful stimulus. This descending pathway includes projections from the midbrain (periaqueductal gray matter), the pons (locus ceruleus), and the medulla (nucleus raphe magnus). These areas have projections that descend down into the dorsal horn, and synapse in rexed's laminae II, at the site of 1^{st} and 2^{nd} order neurons. This in turn causes a release of spinal serotonin and norepinephrine, which ultimately inhibits second order neurons located in the dorsal horn.

NT Involvement in Pain Modulation




Cerebral Cortex
"Somato-sensory"
RIGHT
LEFT
Arm
Hand
FACE
Peri aqueductal Gray Matter
Midbrain
Locus ceruleus
Pons
Brainstem
Nucleus Raphe Magnus
Medulla
DRG
5HT
Noradrengic
Dorsal Horn
Interneuron
1st order neuron
Norad.
5HT
Substance P
Enkephalin Opioid site
2nd order neuron
Substantia Gelatinosa
Opioid Binding site:
- Dorsal Horn, on 1st & 2nd order neurons
Spinal Cord
Enkephalin inhibits Substance P release, inhibits action potential propogation in 2nd order neur

Pain Theories and Common Terms

- **Gate Control Theory:** Postulated by Ronald Melzack and Patrick Wall. Sensations being transmitted via C fibers is modulated through presynaptic inhibition from incoming beta-fibers in the substantia gelatinosa. By activating the beta fibers, the second order neurons located in the substantia gelatinosa are inhibited, effectively reducing and preventing the transmission of a painful sensation to the somatosensory cortex. The constant stimulus applied to the beta fibers override the afferent pain signal coming into the dorsal horn and therefore, provide pain modulation.
- Two relevant examples of this theory: TENS unit application and shaking of the hand when you smash your finger

Pain Theories and Common Terms

- Common Pain Terms:
  - Allodynia- pain produced by a stimulus that DOES NOT normally cause pain
  - Hyperalgesia- increased response to a stimulus that is NORMALLY painful
  - Plasticity- nociceptive input that leads to structural and functional changes that cause altered perceptions
  - Wind Up- slow temporal summation of pain mediated by C-fibers due to repetitive noxious stimulation
  - Central sensitization- acute changes in the responsiveness of second order neurons following high intensity or prolonged stimuli. (inflammation, tissue injury)
    - Both wind-up and central sensitization are linked to NMDA activation

Pain Management Techniques

- Ultrasound Guided Regional Nerve Blockade
- Opioid sparing/free anesthesia techniques
- Chronic Pain Interventions
- Medication Management

Ultrasound Use and Implementation

Basic Ultrasound Physics

- Sound is a longitudinal, mechanical wave that causes periodic oscillations of particles in a medium. Different media cause different reactions and characteristics of the sound.
- Sound is measured in Hertz. 1 Hertz is defined as 1 cycle per second.
- Ultrasound is on the acoustic spectrum above 0.02 megahertz, with medical diagnostic ultrasound occurring between 2-15 megahertz

Image retrieved: https://healthcare-in-europe.com/en/news/a-breakthrough-in-real-time-ultrasound-guidance-for-regional-anesthesia.html, September 2020

Basic Ultrasound Physics

- At different interfaces of medium, sound is reflected back as an echo.
- The greater the difference in acoustic impedance, the more of the sound wave is reflected.
  - Interface between fat and muscle: little sound is reflected back
  - Interface between muscle and bone: a lot of sound is reflected back
    - The difference in impedance is small for fat and muscle but large for muscle and bone. Images are created by the ultrasound machine utilizing these priniciples.

Basic Ultrasound Physics

- Wave Characteristics
  - **Frequency:** Number of cycles of a wave in one second
  - **Wavelength:** length of a wave cycle or peak to peak or trough to trough
  - **Amplitude:** distance from the wave node, or baseline, to either the top of the peak or bottom of the trough (Wave node always has an amplitude of zero)
  - **Velocity:** speed at which waves passes through medium
  - **Period:** time it takes for one complete wave cycle to occur
  - **Interference:** interaction of the waves in the exposed medium

Basic Ultrasound Physics

- Frequency and Attenuation: attenuation is the rate at which a wave's intensity diminishes as it moves through a medium
  - High frequency = High attenuation
  - Low frequency = Low attenuation
- Sound waves with a high frequency and shorter wave length have a high attenuation rate
- Sound waves with a low frequency and longer wave length have a low rate of attenuation
  - This translates clinically to definition and clarity of superficial vs deeper structures (interscalene vs deep abdominal scans)

Basic Ultrasound Physics

- **Propagation Speed:** speed of an ultrasound wave which is determined by stiffness and density of a medium.
  - As the stiffness or rigidity of a medium increases, the propagation speed increases. As the density of a medium increases, the propagation speed decreases.
- **Average propagation speed in human tissue: 1540 m/s**
  - This is the speed at which ultrasound manufactures use in their specifications

Basic Ultrasound Physics

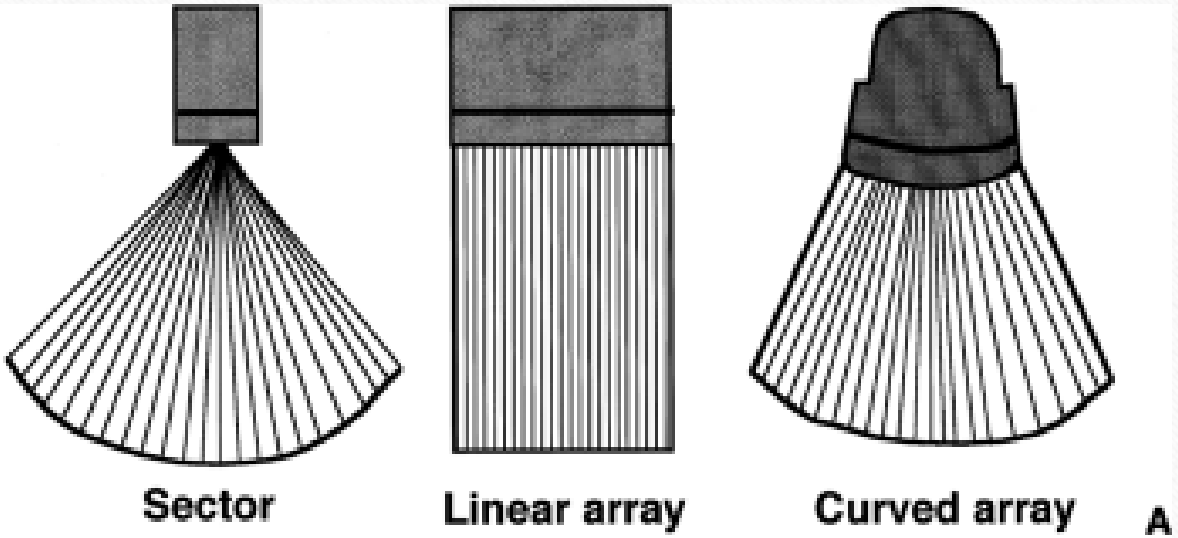
- Ultrasound Modes:
  - B-Mode
    - Grayscale images, captures one still image at a time
  - M-Mode (motion mode)
    - Depicts movement of structures, displays a waveform-like image
  - Doppler
    - Measures change in frequency caused by motion of a source (typically blood flow). Angle of Insonation (doppler angle): 0-20∘ to the blood flow

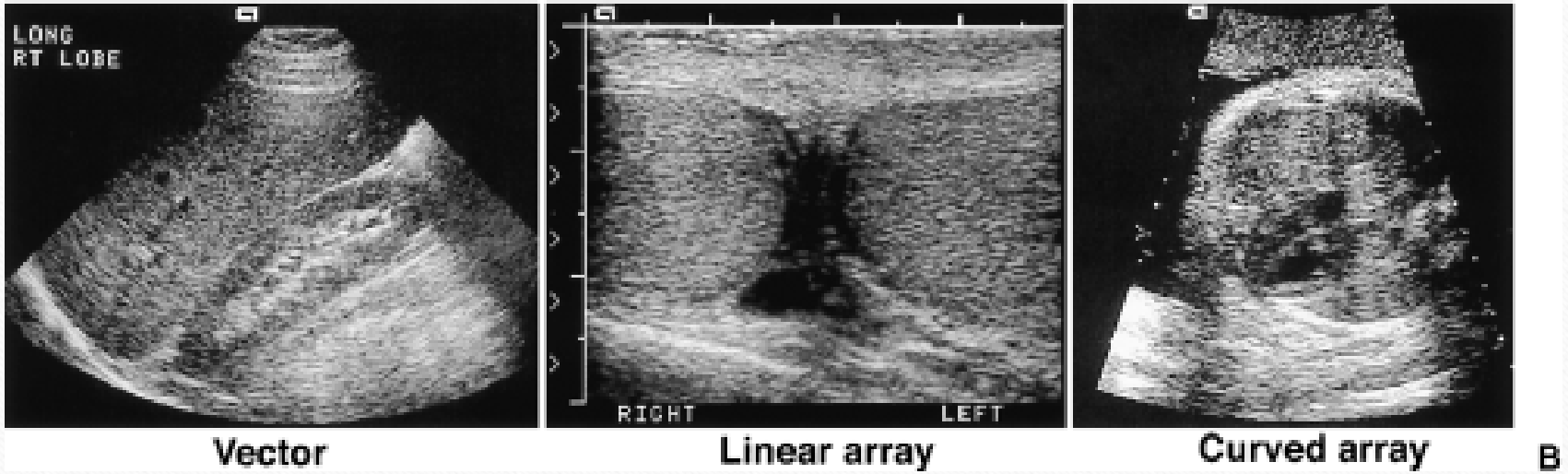
Basic Ultrasound Physics

- Color Doppler Flow
  - Color represents speed and direction of blood flow
  - Remember the pneumonic "**BA RT**"
- **BA: BLUE AWAY from transducer**
- **RT: RED TOWARD the transducer**

Basic Ultrasound Physics

- Types of Transducers
  - Linear Array: High resolution. Frequencies between 7-17 MHz. Rectangular footprint. Structures: musculoskeletal, superficial (i.e. thyroid), Vascular
  - Curvilinear Array: High resolution. Deep penetration at lower frequencies. Trapazoidal footprint. Structures: deeper organs, transabdominal pelvis, neonatal heads, severely swollen extremities
  - Sector Array: Lower frequencies (3-10 MHz). Pie shaped footprint. Ideal for scanning small spaces. Structures: Ribs, Cardiac


Sector
Linear array
Curved array
A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RT LOBE
RIGHT
LEFT
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Pain Management Modalities

Acute/Chronic Pain

- It's important to remember, pain is a continuum. The transition from acute to chronic pain can occur rapidly or slowly. Varies with each patient and condition present.

- Some chronic pain interventions are being utilized and studied for the management of acute pain through pre-emptive analgesic measures.

Acute/Chronic Pain

- Regional Anesthesia
- Opioid free/sparing therapies
- Alternative treatments
- Chronic interventions in the acute setting
- Managing the Chronic pain patient, in the acute setting

Ultrasound Guided Regional

- Employ the use of a pressure monometer to avoid nerve injury
- I recommend a dual technique, utilizing stimulation and ultrasound guidance on all motor blocks
- Frequent aspiration checks to avoid inadvertant vessel injection

Ultrasound Guided Regional: Upper Extremity

- Interscalene
- Supraclavicular/Infraclavicular
- Suprascapular
- Axillary
  - Individual blocking of radial, median, ulnar nerves

Interscalene Nerve Block

- http://neuraxiom2.wpengine.com/techniques/upper-extremity-blocks/interscalene/

Interscalene Nerve Block

- The brachial plexus (C5-T1 nerve roots) can be divided into 5 distinct groups or sections:
  - Roots, Trunks, Divisions, Cords, Terminal Branches
- The brachial plexus supplies all the motor and most of the sensory innervation to the shoulder, clavicle, and upper arm. The exception is the cephalad cutaneous portions of the shoulder being innervated by the supraclavicular nerve, which originates from the superficial cervical plexus (C3-C4 nerve roots)

Interscalene Nerve Block

- Indications:
  - Total/Hemi Shoulder Arthroplasty
  - Proximal humerus surgery
  - Distal clavicle surgery
  - Rotator Cuff surgery
- Contraindications
  - Patient refusal, contralateral diaphragmatic paralysis, infection at insertion site, allergy to local anesthetic, severe respiratory disease, pre-existing neurodeficits in surgical extremity, anti-coagulation

Interscalene Nerve Block

- Pharmacology
  - Post-operative pain management: 0.2-0.25% ropivacaine or bupivacaine, 20 mL
  - Surgical analgesia: 0.5% ropivacaine or bupivacaine, 20 mL
    - Can also use 10 mL 1.3% Exparel + 5 mL 0.25% bupivacaine, 15 mL total (caution with other local use)
  - Adjuvants: +/- PSF dexamethasone 2-4mg
  - Hydrodissection with PSF D5 if using nerve stimulator

Interscalene Nerve Block

- Complications
  - Horner's syndrome:
  - Hoarseness
  - Difficulty swallowing
  - Shortness of Breath
- If performing block more caudal than the level of the cricoid cartilage (C6 level), be certain to scan and locate the transverse cervical artery. This vessel crosses the plexus at this location and can easily be punctured.

Interscalene Nerve Block

- PEARLS
  - Start scanning in the supraclavicular fossa, in a long axis view with the transducer parallel to the clavicle. Find the subclavian artery at this location. The brachial plexus will look like a honey comb structure lying adjacent to the pulsatile structure on ultrasound. Trace this structure up the neck, adjusting probe positioning as needed to optimize the image, until you see the classic "Stop Light" appearance. (C5-C7)
  - The ulnar nerve is derived from the C8-T1 nerve roots, therefore, the interscalane nerve block is NOT sufficient for surgeries of the hand and forearm areas.

Interscalene Nerve Block

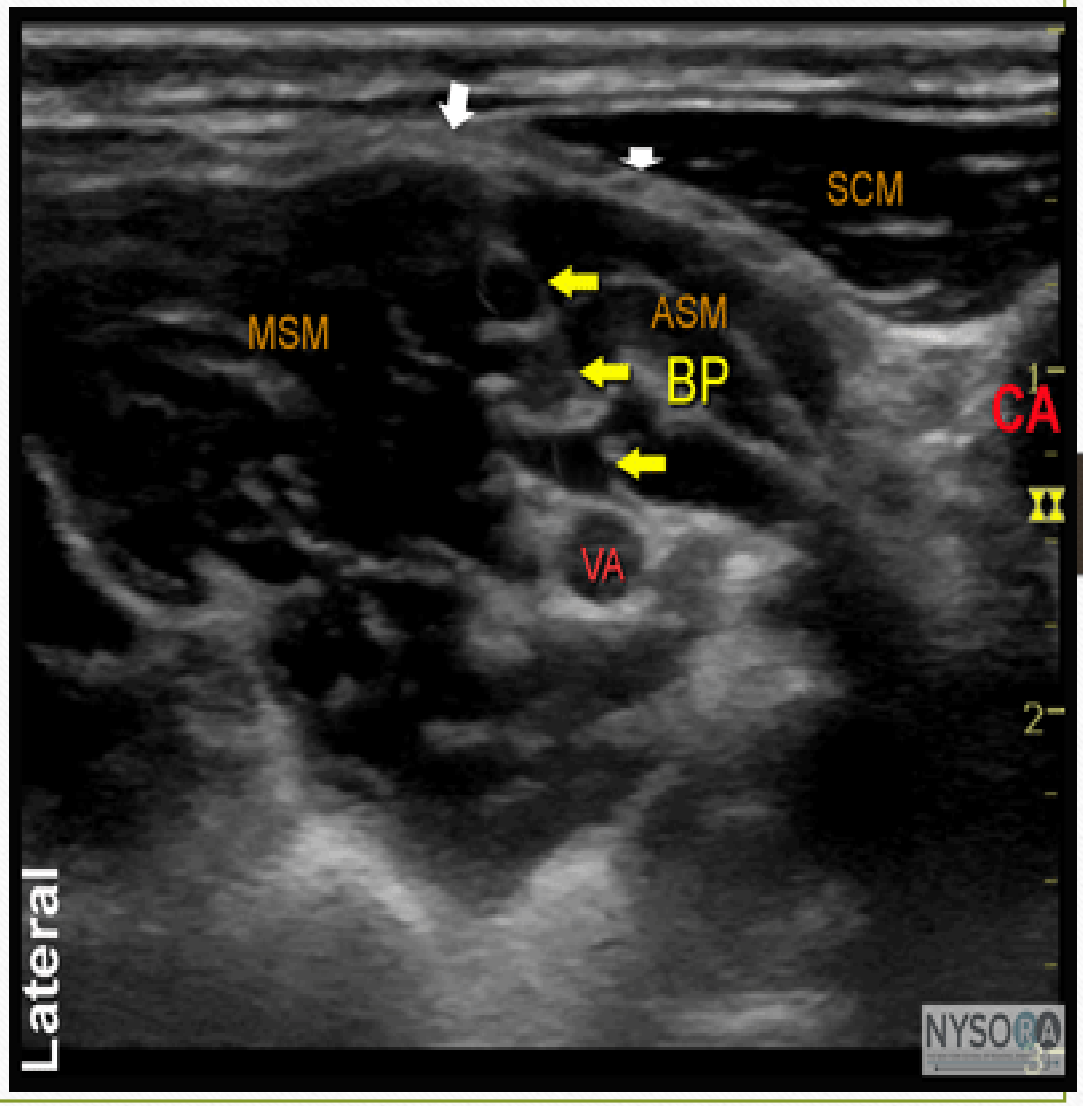
- PEARLS
  - Stimulation:
    - Start stimulation at 0.5 mA once needle tip is confirmed past superficial muscle structures. If stimulating too soon, superficial muscles may contract and distort ultrasound image.
    - Once deltoid twitch is present, decrease intensity of stimulator to 0.2 mA. No twitch should be present at this time. If twitch is still present, it is possible to have intraneural needle placement and needle should be withdrawn.
    - When injecting, injection pressure as monitored by the monometer should always be less than 15 psi. High injection pressures can be indicative of intraneural needle placement

Interscalane Nerve Block

- Catheter placement:
  - Interscalene catheter placement provides prolonged analagesia for those patients requiring extending pain relief. More of an advanced technique. Special considerations with catheter migration, infection, and continuous infusions.
    - Dosing for catheters: dose the initial block via the catheter. If the block fails, you know the catheter needs replaced prior to the surgery.
      - Dose: ropivacaine 0.2%, initial infusion 6 mL/hr. For VAS >7, increase pump to 10 mL/hr for 2 hours for a ”slow” bolus.

Image from NYSORA

http://neuraxiom2.wpengine.com/techniques/upper-extremity-blocks/interscalene/



Supraclavicular Nerve Block

- http://neuraxiom2.wpengine.com/techniques/upper-extremity-blocks/supraclavicular/

Supraclavicular Nerve Block

- Considered the "spinal block" of the upper extremity

- Effectively anesthetizes the trunks and divisions of the brachial plexus. This will anesthetize the entire upper extremity, with the exception of the upper medial, and more superficial region which is innervated by the intercostobrachial nerve, which is derived from T2 nerve root.

Supraclavicular Nerve Block

- Indications:
  - Any surgery involving the upper extremity, up to the shoulder level.
  - With this approach, the cutaneous distribution of the shoulder is blocked but the internal capsule of the shoulder joint is not blocked. This would require a posterior axillary block and those two combined can serve as an alternative to an interscalene block in shoulder surgery.
- The nerves innervating the shoulder and internal capsule are located too far cephalad to be covered with a supraclavicular block solely.

Supraclavicular Nerve Block

- Contraindications
  - Patient refusal, contralateral diaphragmatic paralysis, infection at insertion site, allergy to local anesthetic, severe respiratory disease, pre-existing neurodeficits in surgical extremity, anti-coagulation

Supraclavicular Nerve Block

- PEARLS
  - Inicidence of phrenic nerve blockade is slightly lower than with Interscalene approach.
  - Estimated rates of phrenic nerve blockade with the different BP approaches:
    - Interscalene ~100%
    - Supraclavicular ~50%
    - Infraclavicular ~ complete blockade 3%, partial 13%
    - Axillary ~0%

Supraclavicular Nerve Block

- Dosing:
  - 5-7 mL in close proximity to subclavian artery “corner pocket”
  - 5-7 mL above the subclavian artery
  - 15 mL at the inferior point in the brachial plexus, being certain to avoid contact with axonal tissue
  - 20-30 mL total
    - Surgical anethesia: 0.5% ropivacaine/bupivacaine. Post-op analgesia: 0.2-0.25% ropivacaine/bupivacaine.
    - 16-24 hr duration with the addition of 4mg PSF dexamethasone

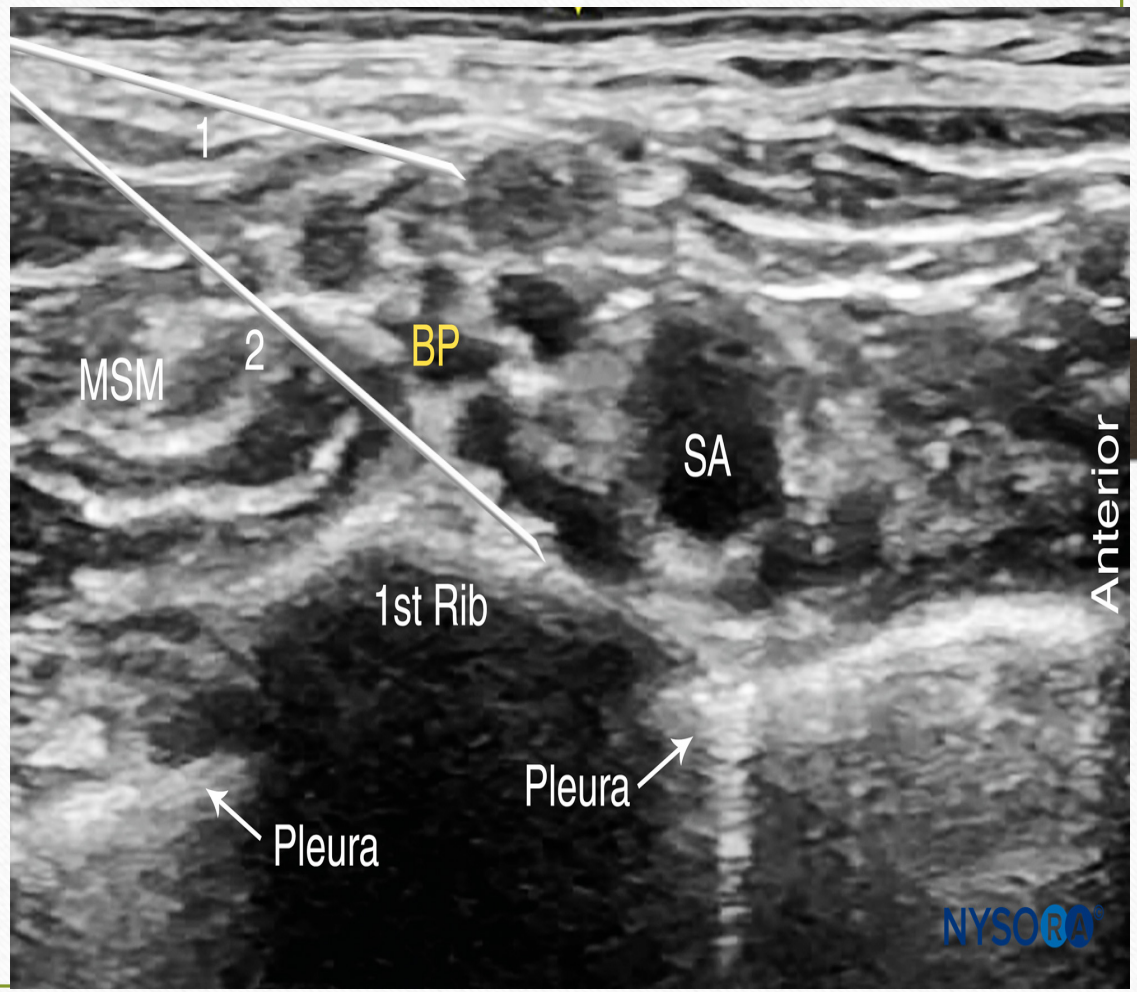
Supraclavicular Nerve Block

- Hand twitch if using nerve stimulator
  - Start initial stimulation at 0.5 mA, then decrease to 0.2 mA

- You should see a distinct elevation of the subclavian artery while performing the corner pocket injection. This will effectively block the ulnar distribution by reaching the trunks/division of C8-T1

http://neuraxiom2.wpengine.com/techniques/upper-extremity-blocks/supraclavicular/

Image from NYSORA



Infraclavicular Nerve Block

- http://neuraxiom2.wpengine.com/techniques/upper-extremity-blocks/infraclavicular/

Infraclavicular Nerve Block

- Very similar to the Supraclavicular nerve block, with the exception of performing this block below the level of the clavicle.
- Clinical indications are similar to supraclavicular: distal humerus, elbow, forearm, hand surgeries/injuries
- Same contraindications
- Same dosing parameters
- Benefits: if space is too narrow or too small in the supraclavicular region, may move distally to the infraclavicular approach. Clavicle fracture or trauma may impede the supraclavicular approach as well.

Infraclavicular Nerve Block

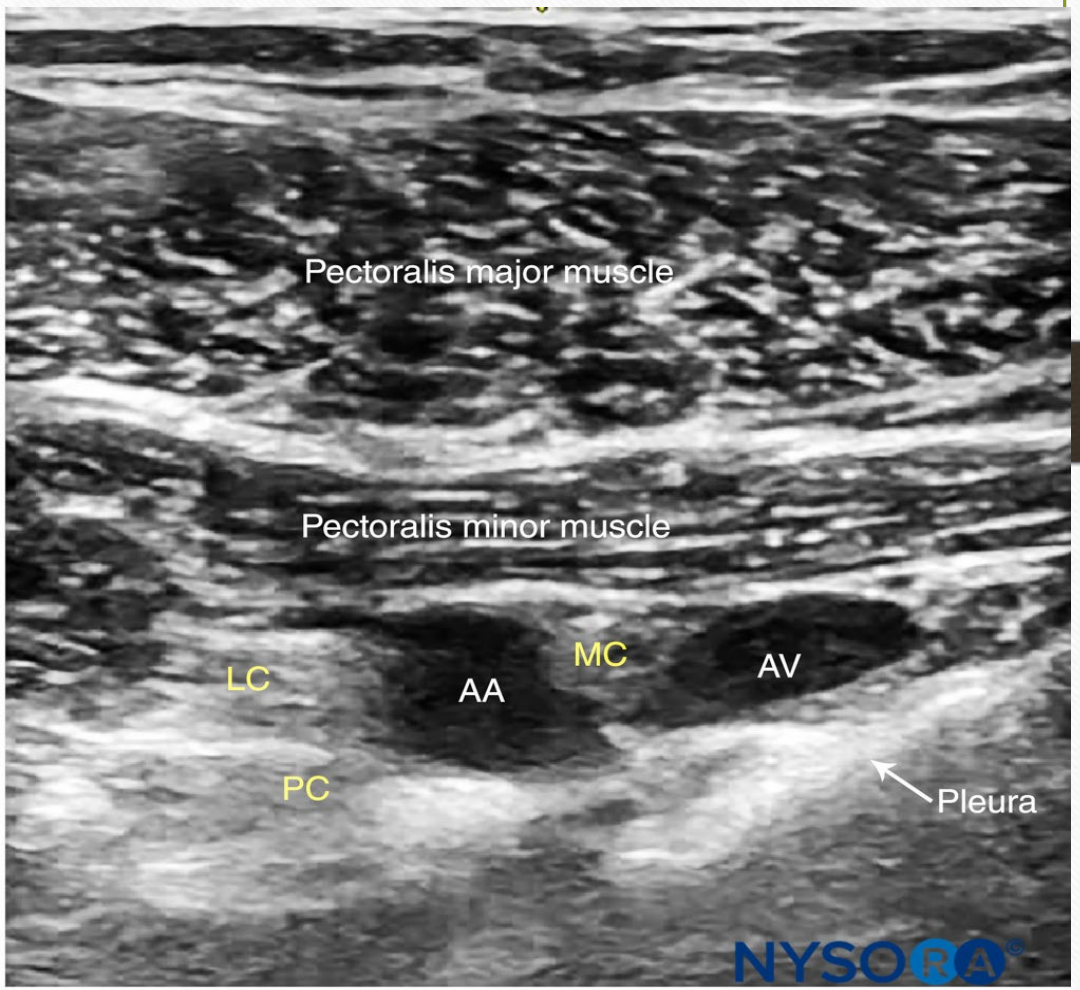
- Blocking the cords below the pectoralis minor muscle
- With this approach, the three major cords are seen surrounding the axillary artery.
  - The lateral cord is the first approached when utilizing a lateral to medial needle insertion. Ideal needle placement is at the six o'clock position relative to the axillary artery. Hydrodissect to separate artery from posterior cord. Once the needle tip lies just below the axillary artery, aspirate and start injection
  - Dose: 15-30 mL of 0.2-0.5% ropivacaine/bupivacaine +/- PSF dexamethasone

Infraclavicular Nerve Block

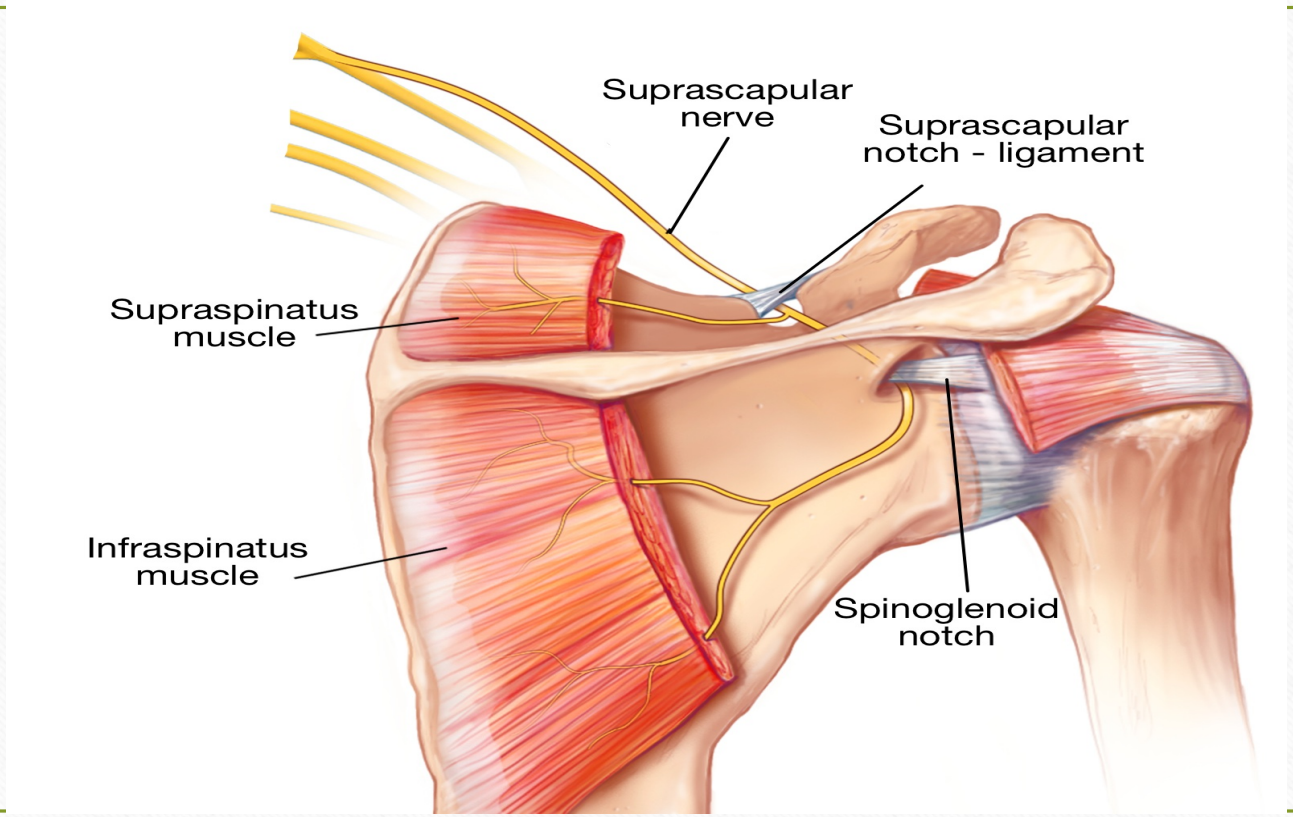
- As with all US guided nerve blocks, be certain to maintain needle visualization. This blocks requires a slightly more “steep” needle angle and increases the likelihood of inadvertent lung injury.

http://neuraxiom2.wpengine.com/techniques/upper-extremity-blocks/infraclavicular/

Image: NYSORA



Suprascapular Nerve Block



Suprascapular Nerve Block

- Utilized to provide analgesia to a large majority of the shoulder joint capsule ~70% and the posterior aspect of the scapula.
- Effectively prevents spasms of the supraspinatus and infraspinatus muscles.
- The suprascapular nerve arises from the superior trunk of the brachial plexus.

Suprascapular Nerve Block

- Mixed nerve: sensory and motor innervations
  - Motor: supraspinatous- arm abduction. Infraspinatous- external rotation
  - Sensory: glenohumoral joint, glenoid, acromion, coracoid process, acromioclavicular joint, subacromial bursa, scapula, coracohumeral ligament, coracoclavicular ligament
- Nerve traverses in neurovascular bundle, with the suprascapular artery and suprascapular vein

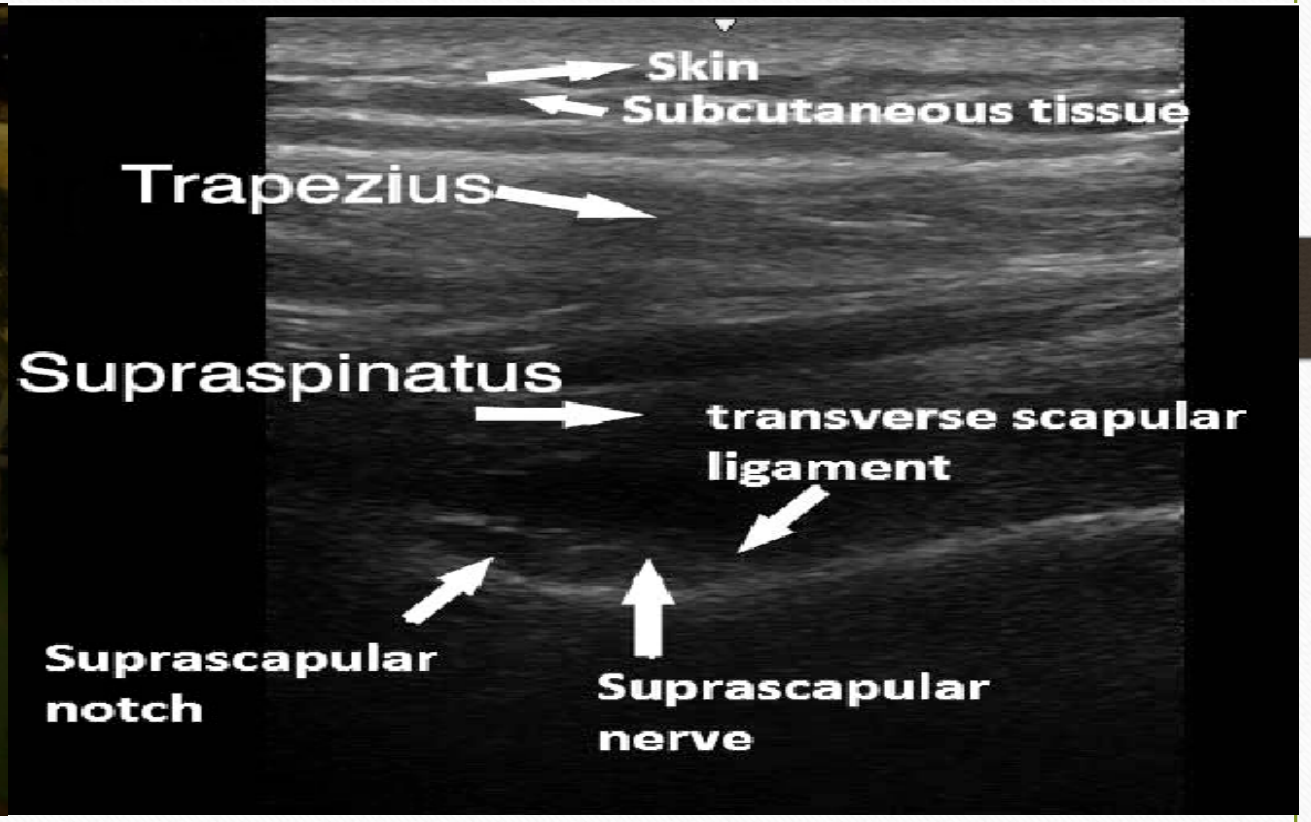
Suprascapular Nerve Block

- Indications:
  - Acute pain, scapular trauma, shoulder dislocation/closed reduction, surgical graph site
  - Chronic pain: frozen shoulder, adhesive capsulitis, rheumatoid arthritis, impingement syndrome, osteoarthritis of shoulder joint
- Contraindications:
  - Patient refusal, traumatic damage to the SSN, infection at injection site, allergy to LA

Suprascapular Nerve Block

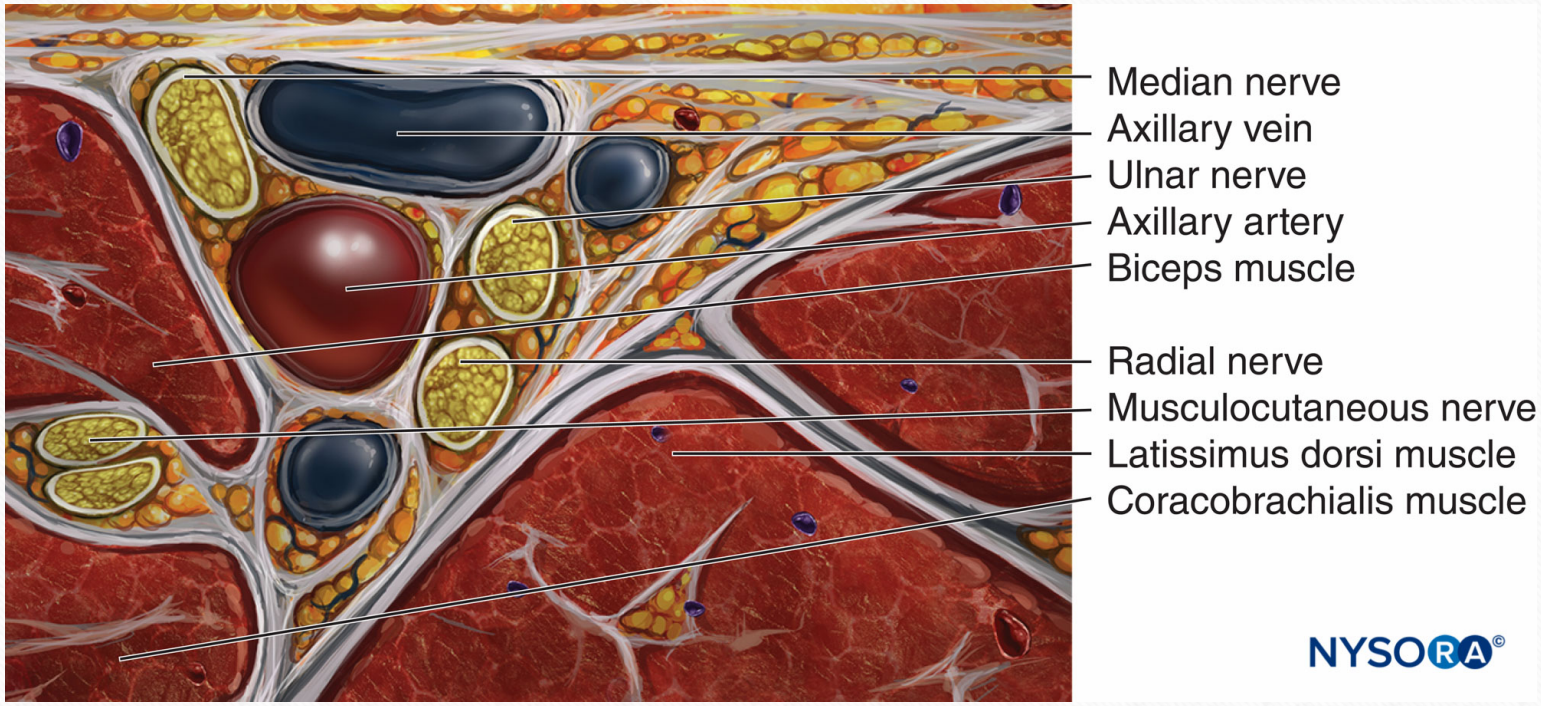
- Placement
  - Transducer placement is on the superior portion of the scapula, along the scapular spine
  - Needle orientation is medial to lateral
  - Continuous aspiration
  - Once the superior transverse scapular ligament (STSL) is penetrated, hydrodissect to confirm needle tip and push vasculature away from needle.
  - Inject 10-15 mL 0.5% ropivacaine/bupivacaine.

Suprascapular Nerve Block



http://www.cambridgeorthopaedics.com/cambridgeanaesthetics/advancednerveblocks/AXNSSN.htm

Axillary Nerve Block



https://www.nysora.com/techniques/upper-extremity/axillary/axillary-brachial-plexus-block/

Axillary Nerve Block

- Two approaches for this particular block
  - Circumflex: used for shoulder procedures in high risk patients
  - Non-circumflex: Used for procedures below the elbow
- Circumflex axillary block can be used in patient's requiring shoulder procedures and have high risk co-morbid conditions
  - Severe respiratory disease, morbid obesity, high risk OSA, conditions where patients cannot have interscalene block
- The axillary nerve is the terminal branch of the posterior cord of the BP

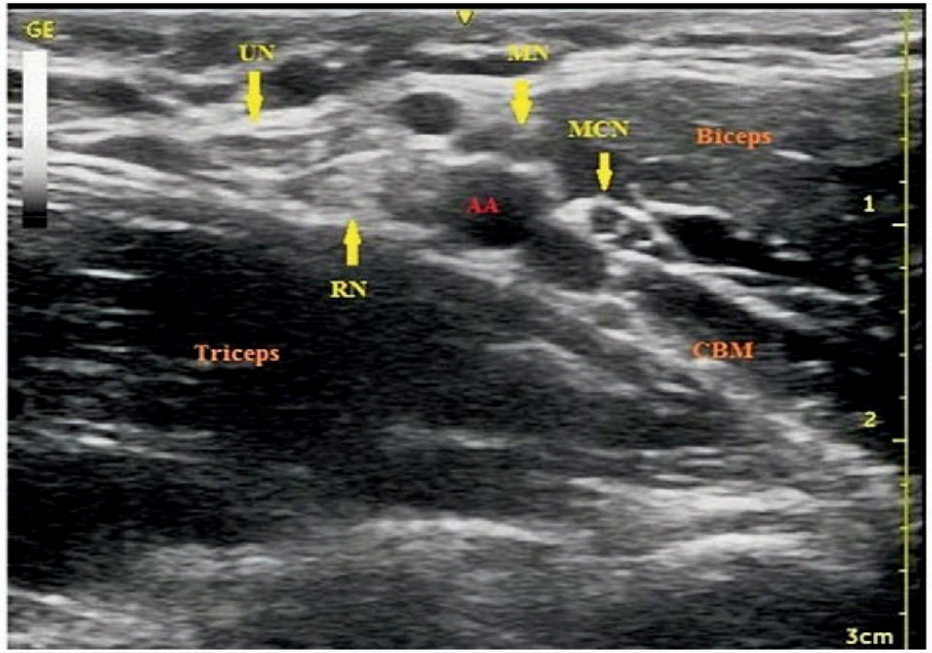
Axillary Nerve Block

- Non-circumflex: Landmarks include musculocutaneous nerve, axillary artery, median, ulnar, and radial nerves.
- Musculocutaneous nerve is located in between the coracobrachialis and biceps muscle. On ultrasound, the musculocutaneous nerve is the brightest nerve in the body and is typically triangular shaped or oval shaped. Inject 5 mL of LA at musculocutaneous nerve.

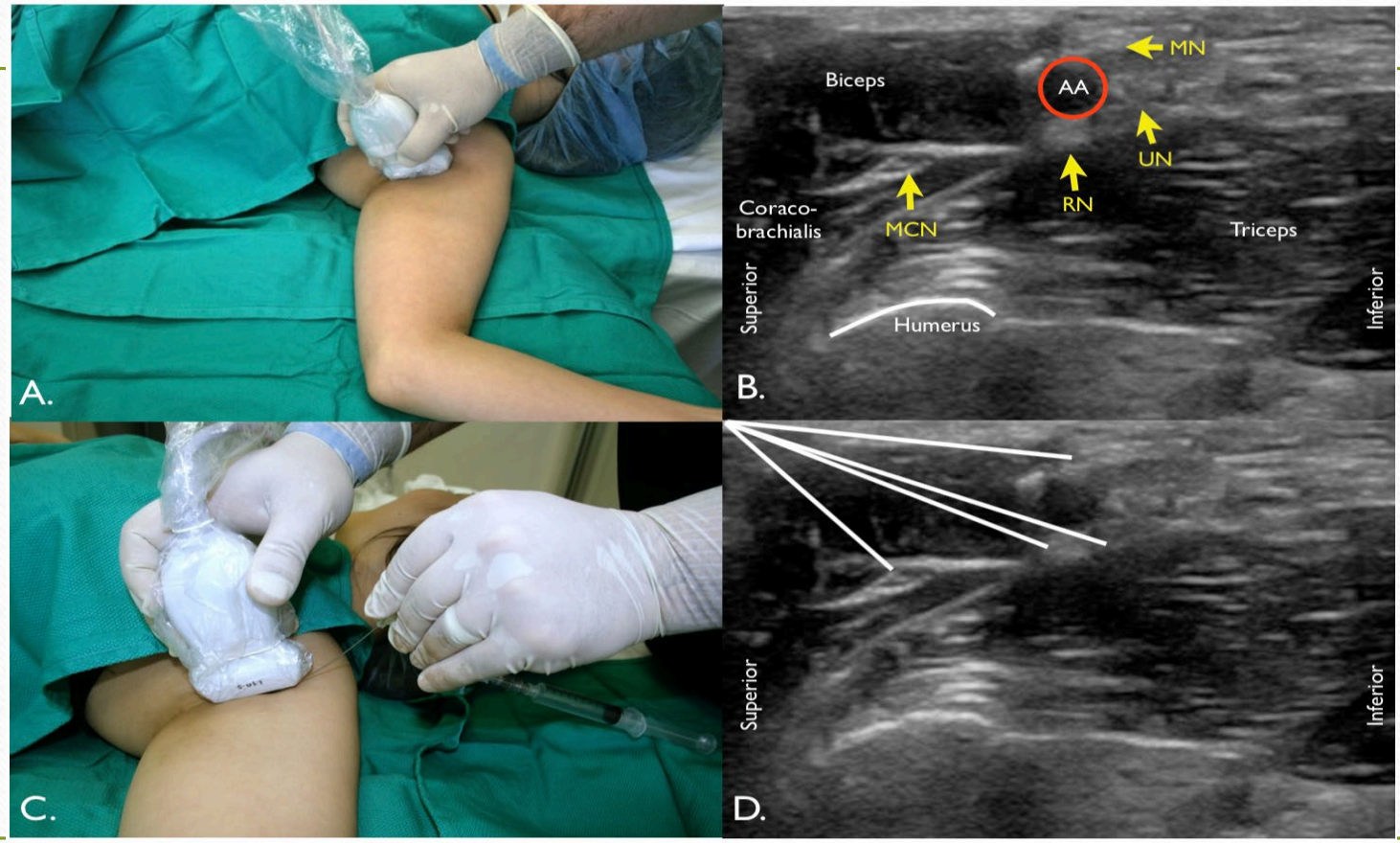
Axillary Nerve Block

Circumflex

Noncircumflex



Axillary-Noncircumflex



Axillary Nerve Block

- Dosing:
  - Circumflex: 10-15 mL 0.75% ropivacaine solution
  - Noncircumflex: 20 mL 0.5% ropivacaine/bupivacaine solution for the radial, median, and ulnar nerves. 5 mL for musculocutaneous nerve
  - Great block for AV fistula creation! (noncircumflex)

Ultrasound Guided Regional Anesthesia: Truncal Blocks

- PECS 1, 2
- TAP
- Ilioinguinal/Iliohypogastric

PECS 1 & 2 Block

- PECS 1 & 2 blocks can be utilized for many different procedures involving the anterior chest wall and breast regions.
  - PECS 1: insertion of breast expanders, subcutaneous prosthesis, traumatic chest injuries, pectoral muscle disections, pacemakers, subcutaneous port insertions, chest drains
  - PECS 2: mastectomy and axillary clearance

PECS 1 & 2 Blocks

- Nerve Innervation:
  - PECS 1: Medial and Lateral pectoral nerves
  - PECS 2: Long thoracic nerve, thoracodorsal nerve, and anterior & lateral intercostal cutaneous nerve branches (T2-T4)
- Landamarks: Axillary artery, 3rd rib, thoracoacromial artery, and pecs major/minor

PECS 1 & 2 Block

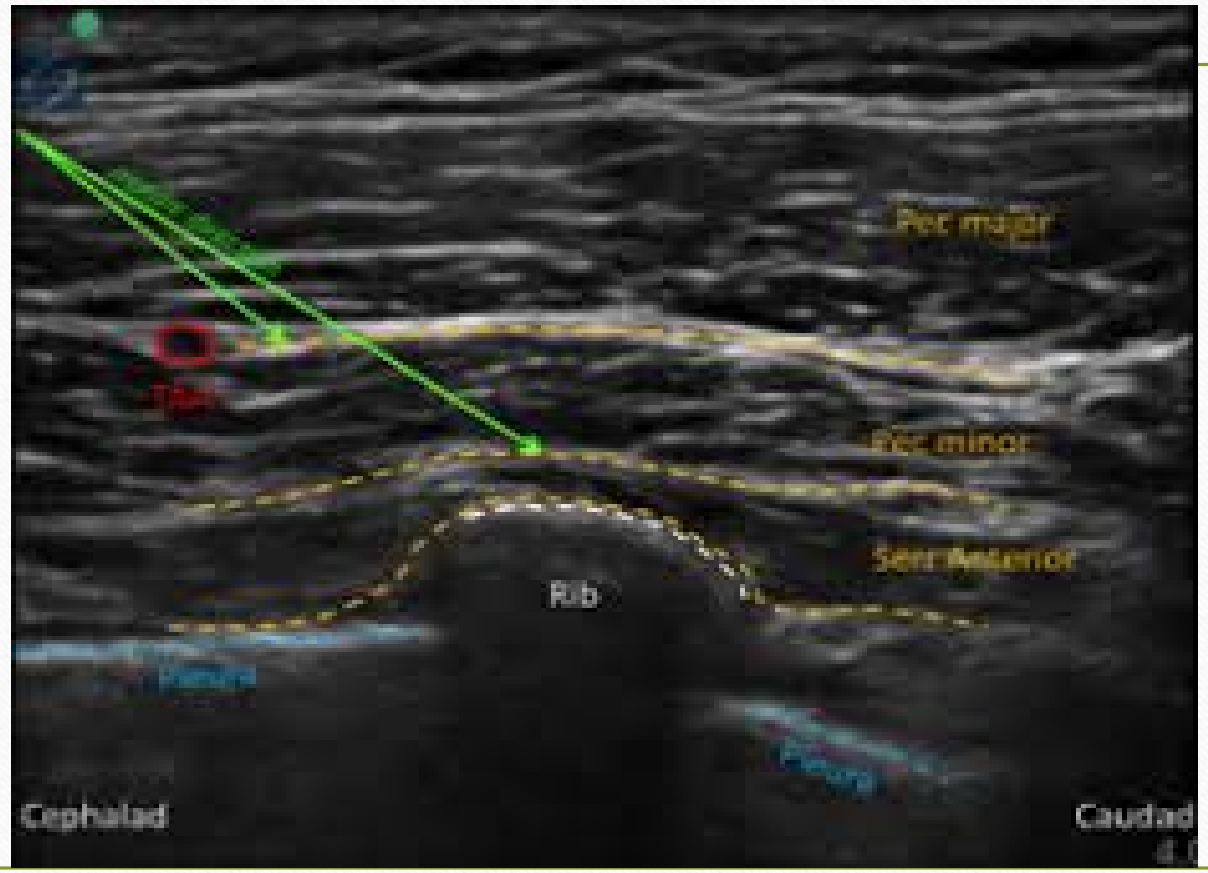
- Probe Placement

https://www.wfsahq.org/components/com_virtual_library/media/7ef4612aa547d759a2e24087424e9bba-ATOTW346.pdf

PECS 1 & 2 Blocks

- Dosing:
  - PECS 1: Medial and Lateral pectoral nerves lie adjacent to the thoracoaromial artery. Use 10 mL 0.2% ropivacaine/bupivacaine
  - PECS 2: Fascial plane block (use volume)- 20 mL 0.2% ropivacaine/bupivacaine
    - Hydrodissect with PSF saline to confirm needle tip and spread within the correct plane, below PECS minor and above serratus anterior
  - Additives: PSF dexamethasone 4 mg (2 mg for each block)

PECS 1 & 2 Block



https://www.wfsahq.org/components/com_virtual_library/media/7ef4612aa547d759a2e24087424e9bba-ATOTW346.pdf

TAP Block

- Fairly simple block to perform. Depending upon injection site, dermatomal coverage from T7-L1.
- Injection site is between the internal oblique muscle group and the transversus abdominis muscle. This is a fascial plane block.
- This block can be performed awake or under anesthesia. Depending upon the procedure, bilateral vs unilateral placement as well.
- Volume is the key with fascial plane blocks, as you want to maximize the spread of local.

TAP Block

- Indications
  - Compartment block, provides somatic pain relief, abdominal procedures
  - Can be done pre-operative, intra-operative, post-operative
- Innervation of the abdominal wall
  - Intercostal nerves: T7-T11
  - Subcostal nerves: T12
  - Ilioinguinal/Iliohypogastric: L1 (can also perform transversalis fascia block: T12-L1)

TAP Block

- Dosing
  - Analgesic dosing: 30 mL 0.2% ropivacaine/bupivacaine each side
  - Hydrodissetion with PSF saline to confirm needle tip. Goal is to see the fascial plane between the internal oblique muscle and transversus abdominis muscles “unzip” from the local spread
  - PSF dexamethasone 4 mg to prolong block duration

TAP Block

https://www.twinoaksanesthesia.com/tap-block

TAP Block

- Great write up regarding the use of a TAP Block as the sole anesthetic in the AANA journal….LOL

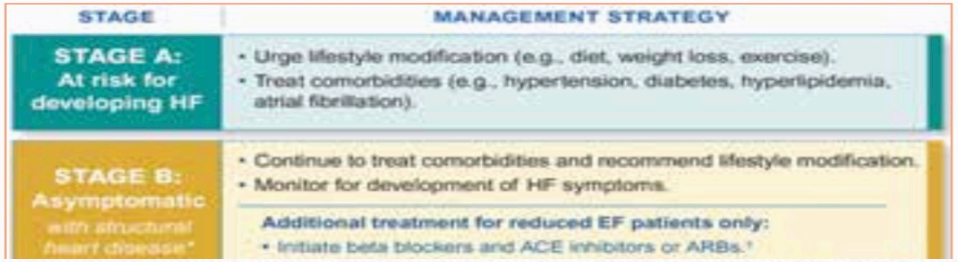
Anesthetic Management of a Patient with Severe Diastolic Dysfunction for Umbilical Hernia Repair: A Case Report

Kellon S. Smith, MHS, CRNA

Research has shown that 1 out of 3 people aged 55 or older will develop heart failure, which is often a fatal prognosis. Investigations have demonstrated that 35% of heart failure patients will succumb to their condition within 5 years of onset. Worldwide, it is estimated that 23 million people are living with and suffering from symptoms associated with heart failure. Heart failure can result from various sequences of events, and ultimately effect either the systolic or diastolic function of the cardiovascular system. Depending upon which condition is present, anesthesia providers must take into consideration the risk factors associated with heart failure and undergoing anesthesia for various surgical procedures. This case report will examine the anesthetic management of a patient with a known diagnosis of severe left ventricular diastolic dysfunction, with acute exacerbation of congestive heart failure, who presented to the emergency room with an incarcerated umbilical hernia.

Keywords: Diastolic dysfunction, heart failure, regional anesthesia, transversus abdominis plane, truncal blocks.

Statistics collected by the National Discharge Hospital Survey (NDHS) reported that 5.8 million people within the United States are suffering from congestive heart failure (CHF).[1] During a retrospective study of hospital admissions occurring between the years 2000 and 2010, over 1 million hospital admissions were a direct



STAGE	MANAGEMENT STRATEGY
STAGE A: At risk for developing HF	• Urge lifestyle modification (e.g., diet, weight loss, exercise). • Treat comorbidities (e.g., hypertension, diabetes, hyperlipidemia, atrial fibrillation).
STAGE B: Asymptomatic with structural heart disease*	• Continue to treat comorbidities and recommend lifestyle modification. • Monitor for development of HF symptoms. Additional treatment for reduced EF patients only: • Initiate beta blockers and ACE inhibitors or ARBs.†

Ilioinguinal/Iliohypogastric Nerve Block

- This is essentially a low placed TAP block. Most commonly performed for open inguinal hernia repair.
- Block is placed in the TAP plane, in close proximity of the Anterior Superior Iliac Spine. The two nerves can be visualized on ultrasound in this location. Be certain to scan for circumflex artery and other vessels in the area.
  - Maintain visualization of ASIS on ultrasound image and TAP plane

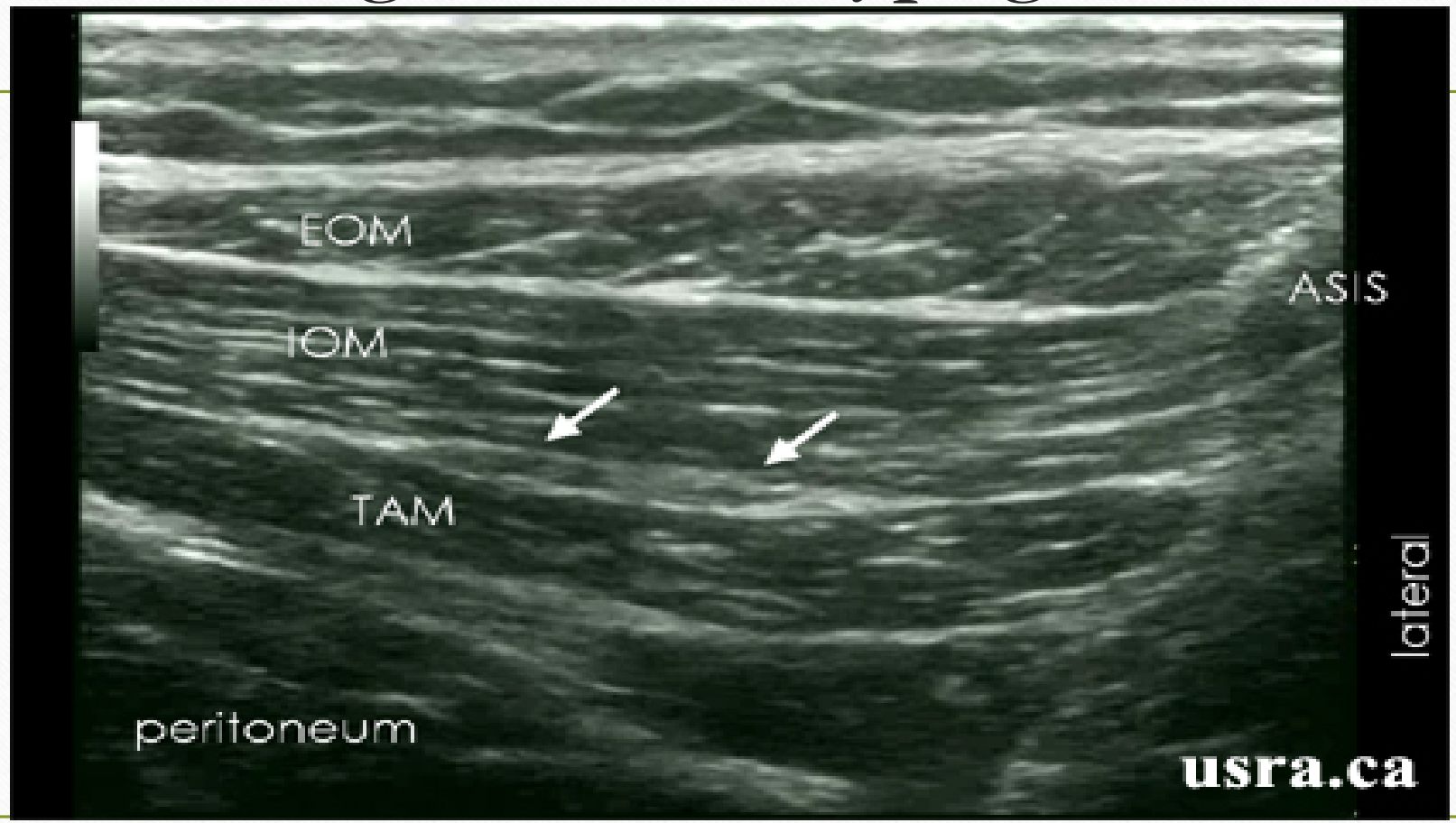
Ilioinguinal/Iliohypogastric Nerve Block

- Dosing
  - 20 mL 0.5% ropivacaine/bupivacaine
  - +/- PSF 4 mg dexamethasone
  - Placing this block for an inguinal hernia procedure allows for the avoidance of narcotic pain control and need for general anesthesia. Commonly performed with propofol infusion.
  - Probe placed on ASIS, in line with the umbilicus to optimize the image

Ilioinguinal/Iliohypogastric Nerve Block

https://www.nysora.com/techniques/truncal-and-cutaneous-blocks/truncal-and-cutaneous-blocks/

Ilioinguinal/Iliohypogastric



Ultrasound Guided Regional Anesthesia: Lower Extremity

- Femoral
- Adductor Canal (Distal Femoral Triangle)
- Popliteal Fossa (Sciatic)

Femoral Nerve Block

- http://neuraxiom2.wpengine.com/techniques/lower-extremity-blocks/femoral/

Femoral Nerve Block

- The femoral nerve originates from the L2-L4 ventral rami
- Blocking the femoral nerve provides surgical or analgesic coverage to the anteriomedial aspect of the lower extremity.
- Below the inguinal ligament, the location of the femoral nerve is within what is called the "femoral triangle". This triangle is comprised of adductor longus (medial side) and sartorius (lateral side) muscles.

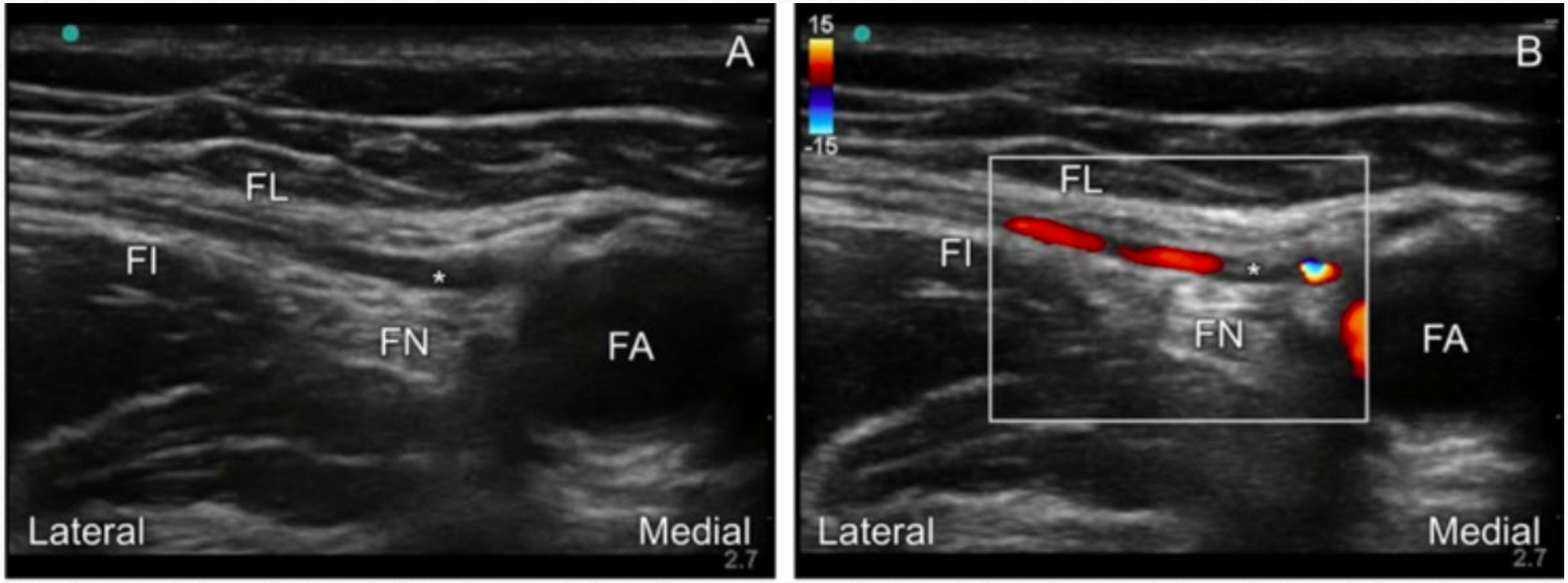
Femoral Nerve Block

- Indications:
  - Total knee arthroplasty (not routinely used for this), ACL/MCL repair, patella fractures, and other procedures involving the lower extremity on the anteriomedial side
- The femoral nerve has anterior and posterior divisions or components.
  - Anterior: sensory to the antero-medial thigh, motor to the sartorius and pectineus muscles, and articular branch to the hip
  - Posterior: sensory to the saphenous distribution, motor to the quadriceps muscles, and articular branch to the knee

Femoral Nerve Block

- Dosing:
  - Surgical anesthesia- 0.5% ropivacaine/bupivacaine 20 mL
  - Post Operative analgesia- 0.2-0.25% ropivacaine/bupivacaine 20-30 mL
  - Additives: PSF Dexamethasone 4 mg
- Stimulation: 0.5 mA watching for quad response, then decrease to 0.2 mA. Remember, no muscle response at 0.2 mA prior to injection
- Be sure to have only one artery in your ultrasound image. If too distally, the profunda may be seen and adds to the likelihood of vessel puncture.

Femoral Nerve Block



www.neuraxiom.com

Adductor Canal Block

- http://neuraxiom2.wpengine.com/techniques/lower-extremity-blocks/adductor-canal/

Adductor Canal Block

- A variation of the femoral nerve block, where the target block area is where the femoral nerve transitions into the saphenous nerve. By blocking at this location, you will spare quadriceps strength and allow early ambulation in total knee patients. This is the main reason why femoral blocks are not routinely utilized in total knee arthroplasty.
- Indications: any surgery of the knee that involves the anterior aspect, any surgeries within the saphenous distribution or medial side of the lower leg

Adductor Canal Block

- Probe placement occurs on the upper third of the medial thigh of the operative side. The key landmarks at this location are the sartorius muscle, vastus medialis, and adductor longus muscles. The femoral artery (superficial) can be seen at this location.
- The sartorius muscle has a "boat" like appearance. The femoral artery can be seen sitting just underneath the sartorius. As you scan distally and proximally, the sartorius muscle can be seen "rolling" over the artery. It's important to acquire the location where the artery is near the tip of the sartorius, to avoid the need for traversing the sartorius muscle.

Adductor Canal Block

- Nerve to the Vastus Medialis
  - This nerve arises from the femoral nerve as well, and supplies some motor function to the posterior aspect of the knee/leg.
  - Can provide analgesia to the extramuscular, intramuscular, and deep genicular nerves of the knee.
  - Can be blocked during the adductor canal block with the saphenous nerve

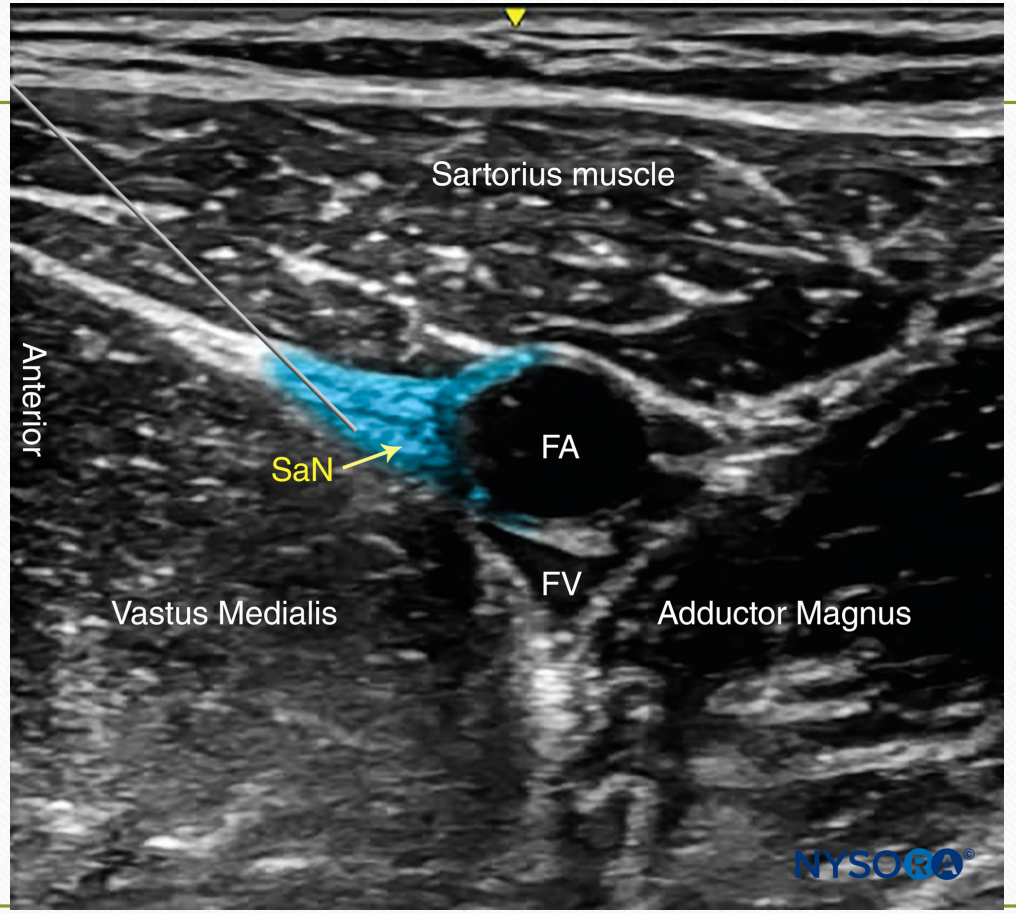
Adductor Canal Block

- Dosing:
- Single Shot:
  - Post-operative analgesia- 0.2-0.25% ropivacaine/bupivacaine 20-30 mL
  - Surgical anesthesia- 0.5% ropivacaine/bupivacaine 20 mL
  - Additives: PSF dexamethasone 4 mg

Adductor Canal Block

- Dosing
- Catheter management:
  - Ropivacaine 0.2%
    - Initial infusion started at 10-12 mL/hr
    - VAS >7 : increase pump to 16 mL/hr for 2 hrs. (This will deliver a slow bolus) After the two hours, return pump to original rate.
    - If patient experiences quad weakness or inability to do a straight leg raise, immoblize knee and decrease pump to 8 mL/hr.

Adductor Canal Block



https://www.nysora.com/regional-anesthesia-for-specific-surgical-procedures/lower-extremity-regional-anesthesia-for-specific-surgical-procedures/foot-and-anckle/ultrasound-guided-saphenous-subsartorius-adductor-canal-nerve-block/

Popliteal Fossa (Sciatic)

- http://neuraxiom2.wpengine.com/techniques/lower-extremity-blocks/popliteal/

Popliteal Fossa (Sciatic)

- The sciatic nerve originates from the L4-L5 and S1-S3 ventral rami roots
- The popliteal fossa block is a block of the distal portion of the sciatic nerve. The ideal location for this block, if sciatic blockade is desired, is above the bifurcation of the sciatic nerve.
  - The sciatic nerve bifurcates into the tibial nerve and common peroneal nerve around the level of the posterior knee

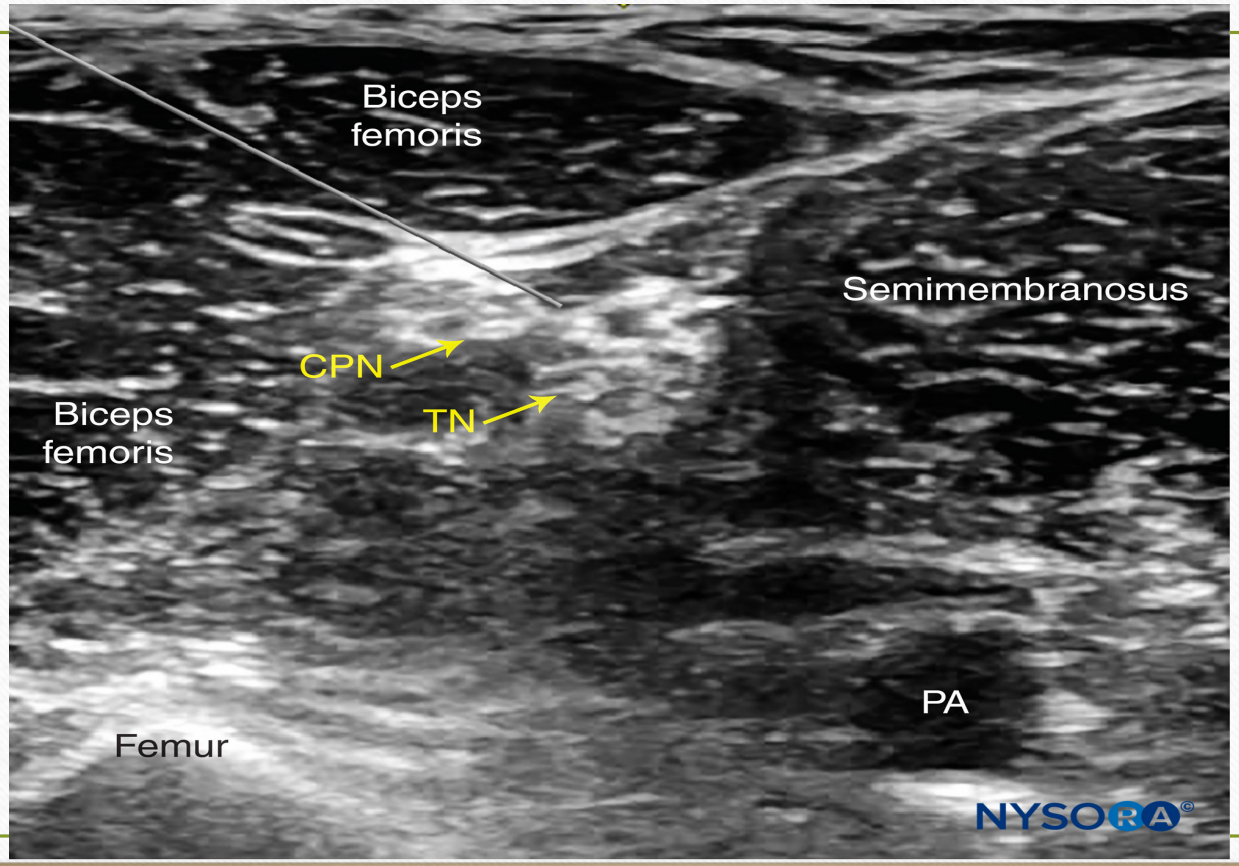
Popliteal Fossa (Sciatic)

- Dosing:
  - Post-operative analgesia: 0.2-0.25% ropivacaine/bupivacaine 20-30 mL
  - Surgical anesthesia: 0.5% ropivacaine/bupivacaine 20 mL
  - Additives: PSF dexamethasone 4mg
- Stimulation: Muscle response is dependent upon needle location and nerve being stimulated. The sciatic motor response can be remembered using "TIPPED" (T-tibial I-Inversion and P-Planter flexion; P-Peroneal E-Eversion and D-Dorsiflexion) Start current at 0.5 mA, decrease to 0.2 mA after response noted.

Popliteal Fossa (Sciatic)

- Landmarks
  - Biceps femoris, semi-tendonosus, semi-membranosus muscles, popliteal artery, popliteal vein, sciatic nerve (prior to bifurcation)
  - It is possible to do a selective block of the tibial nerve and/or common peroneal nerve depending upon surgical needs.
  - Scan distally and observe the nerves split into the bifurcation. The tibial nerve will lie above the artery and the common peroneal nerve will appear to move laterally away from the artery.

Popliteal Fossa (Sciatic)



https://www.nysora.com/regional-anesthesia-for-specific-surgical-procedures/lower-extremity-regional-anesthesia-for-specific-surgical-procedures/foot-and-anckle/ultrasound-guided-popliteal-sciatic-block/

Opioid Sparing Techniques/ Alternatives

- Naturally, providing regional anesthesia allows for reduction in opioid and narcotic medications
- Reducing opioids and narcotic medications leads to reduced length of stay, fewer complications after surgery, and overall, enhanced recovery.
- Opioid effects can change with use
  - Opioid tolerance (receptor desensitization), opioid induced hyperalgesia, worsening pain state

Ketamine

- Remember Wind Up and Central sensitization is mediated via NMDA receptors.
- **Ketamine**
  - Ketamine is a great pain medication. Ketamine, through antagonsim of NMDA receptors, can blunt and reduce wind-up and central sensitization conditions
  - Dose: Subanesthetic dose: 0.3 mg/kg. Can add benzo to offset psychomimeic effect if needed. Infusion: 0.12-0.2 mg/kg/hr for 24-72 hrs post-operatively
    - Opioid sparing to 50%. Effectively decreases incidence of opioid induced hyperalgesia
- Useful in chronic opioid dependent patients

Ketamine

- Clinical use:
  - Short case <60 min: 0.1-0.3 mg/kg IV bolus with infusion
  - Long case (no post-op infusion): 0.1-0.3 mg/kg IV bolus with induction
    - Repeat bolus of 0.1-0.3 mg/kg IV bolus every 30-60 min during operation
    - Avoid dose within 30 minutes of emergence
  - Post-op infusion: 0.1-0.3 mg/kg IV with induction, followed by 0.1-0.2 mg/kg/hr infusion. Can continue infusion for 24-72 hours. After 24 hrs, consider reducing dose to 10 mg/hr or less

NSAIDS

- 600 mg of ibuprofen is comparative to 15 mg oxycodone
- Can reduce opioid use by 50%
- Reduced incidence of Opioid induced hyperalgesia
- Alter platelet function through thromboxane A2 inhibition
- Improved benefit with concurrent administration of acetaminophen

NSAIDS

- Ketorolac
  - IV 30-60 mg every 12 hours; <50 kg: 15 mg
  - Reduce dose in elderly, don't exceed 120 mg/day >50kg; 60 mg/day if <50 kg
  - Nasal spray available: 1 spray equals 15 mg
- Ibuprofen (Caldolor) IV Form
  - 400-800 mg every 6 hours. Infused over 5-7 minutes
  - Approved for 6 months or older. 33% reduction in VAS scores at rest with 800 mg

Celebrex

- Avoids the GI, platelet, and renal effects of the nonselective NSAIDS.
  - This is mainly attributed to blocking only COX 2 enzyme
- 400 mg PO pre-op. 200 mg may be repeated if needed on the first day.
  - Then, 200 mg PO daily
- AVOID in CABG patients and higher risk of CV events

Acetaminophen

- Contraindicated with liver failure.
- Reduces 24 hour morphine consumption
- Ofirmev (IV preparation)
  - Bypasses first pass metabolism
  - >50 kg: 1000 mg every 6 hours, infused over 15 min. Max dose is 4000 mg/day. Caution with PO pain meds containing acetaminophen and ETOH abuse patients
  - > 2 yr old < 50 kg: 15 mg/kg every 6 hrs

Alpha 2 Agonists

- Analgesia through specific supraspinal and spinal Alpha-2 receptors
- Has inhibitory activity on pre and post synaptic pathways.
- Hyperpolarizes nerve terminal
- Two more common medications
  - Clonidine
  - Dexmedetomidine

Clonidine

- PO doses of 0.1, 0.2, and 0.3 mg tabs.
- Patches provide 7 day dose (same as PO)
- Can be given PO pre-op (consider NPO times)
- Can be added as a regional adjunct
  - Prolongs analgesia and LA duration. Improves block density
- Hypotension/Bradycardia are common and dose-related

Dexmedetomidine

- Dosing : Hypotension/bradycardia noted in escalating doses beyond 1 mcg/kg
  - Peripheral Blocks- 1mcg/kg. Significant block prolongation
  - IV
    - Bolus 0.6-1 mcg/kg
    - Infusion: 0.3-1 mcg/kg/hr
  - Spinal
    - NOT FDA approved for this
    - 5-10 mcg

Gabapentinoids

- Decreases neuronal excitability, activates descending inhibitory noradrenergic systems, and decreases release of excitatory neurotransmitters
- Historically given as a treatment in chronic pain patients, such as neuropathic pain (postherpetic neuralgia) and seizures
- Reduces opioid consumption
- Best given pre-operatively, but also effective post-op
- Can cause increased sedation and respiratory depression, especially in elderly
- Useful in treatment of neuropraxic pain caused by needle trauma

Gabapentin

- Dosing
  - Doses > 300 mg have been shown to have higher incidence of sedation/resp. depression post-op
  - Doses as high as 600 mg given pre-op shown to be more effective, but also have more adverse effects (elderly and renal populations)
  - Ideal: 300 mg PO 2 hours before surgery and continued post-op at 300 mg daily PO
- Varying stances on D/C medication: studies show one dose post-op, while others have continued medication post-operatively for 5-14 days

Pregabalin

- 2 hours prior to incision
- No generic equivalent (Lyrica)
- No study has shown advantage of pregabalin over gabapentin
- Dose
  - 150 or 300 mg pre-op, with dose reductions in edlerly and renal populations
- Same side effect profile as gabapentin

Craniofacial Pain/ Botox Injections

- Craniofacial blocks can be utilized for a wide array of chronic conditions
- Tension headache, spasmodic headache, migraine, etc.
- Botox has FDA approval for chronic migraine treatment
  - 3 month dosing guidelines
  - Must have 15 or more days each month with migraine, lasting longer than 4 hours.
  - 18 years and older
  - 31 injection sites

Botox Injections

- 31 Injection sites, utilizing small Sub-q syrine and needle
- Doses are distributed bilaterally
- Caution at injection sites, could cause raised eyebrows, altered smiles, etc. lasting 3 months
- Total dose is 155 units
  - 0.1 mL = 5 units of Botox
  - When reconstituting, spin the bottle in hand. Do not shake.

Botox Injections

- Injection Sites
  - Frontalis: 20 units over 4 sites
  - Corrugator: 10 units over 2 sites
  - Procerus: 5 units 1 site
  - Occipitalis: 30 units divided in 6 sites
  - Temporalis: 40 units divided in 8 sites
  - Trapezius: 30 units divided in 6 sites
  - Cervical paraspinal muscle group: 20 units divided in 4 sites

Botox Injections

https://www.healthcentral.com/article/botox-for-chronic-migraine-knowledge-of-anatomy-is-critical

Management of the Chronic Pain Patient and Chronic Opioid/ OAT Patients

- Patients receiving long-term opioid therapy are at higher risk for adverse events associated with pain medications
  - Use shorter acting opioids
  - Employ regional anesthesia if possible. Use previously discussed multimodal strategies with the non-narcotic medications
- Under treatment of pain is more common in this patient population due to current treatment programs

Management of the OAT Patients

- If patient is on methadone, there are two approaches to treating acute pain issues:
  - Continue methadone maintenance dose
    - Oral
    - Parenteral (50-75% of oral total daily dose): in divided doses
  - Use Short acting opioid analgesics and multimodal strategies

Management of the OAT Patients

- If patient is receiving Subutex or Suboxone:
  - Half life is 24-60 hours
  - Varying strategies and practices
  - Can D/C subutex and suboxone 72 hrs prior to surgery.
    - Buprenorphine can be discountinued over a 2-3 week period with gradual decrease of 2 mg/day, every 2-3 days.
    - Buprenorphine can also be tapered rapidly over the 72 hours

Thank You!

Please feel free to contact me with any questions you may have.

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